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ABSTRACT

The Mathematics Skill Test (MAST) is a test designed to show a student's 10-skill profile of mathematics competencies deemed necessary for success in high school chemistry. It was administered in May to tenth-grade students at two schools. On the basis of the results, students were enrolled for advanced or regular chemistry, or were advised to take remedial math, or were advised not to take chemistry at all. In addition, specific skill deficiencies were used to individualize each student's work in chemistry. Correlations with other achievement measures are reported as well as a general evaluation of MAST's success as a rostering instrument. (Author/LS)

The Mathematics Skill Test (MAST) as Rostering and Diagnostic Tools

by

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The Mathematics Skill Test, MAST as Rostering and Diagnostic Tools[1]

BACKGROUND

The Mathematics Skill Test (MAST) is a 60-item, 45-minute power test designed to show a student's basic competence in 10 mathematics skills needed to succeed in high school chemistry.[2] In 1970, MAST proved to be a reliable criterion reference for high school students of chemistry in the Philadelphia Public schools (r=.967, K-R#20; correlation with 1969 ACS-NSTA High School Chemistry Test = .8). Thus the questions arose: Could MAST be useful in defining the math skills of a student prior to the student's enrollment in chemistry? Could MAST be a useful rostering tool for chemistry enrollment?

In September, 1970 in a Philadelphia inner city high school 75 students rostered in three sections of 1st year high school chemistry took MAST; the purpose: To give a 10-skill profile[3] of math competence (See Table 1) for each of these students. The chemistry teachers thus hoped to anticipate remediation needs prior to math difficulties but lack of funds for math tutoring and rescheduling of teachers' time eliminated the planned remediation work during the ensuing academic year. The ASC-NSTA High School Chemistry Test (1969) was used to evaluate the chemistry achievement in June, 1971, 8 months after MAST testing. A significant correlation of performance, was shown between

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[1]This investigation was funded by the Spencer Foundation.

[2]R. T. Denny, "The Mathematics Skill Test (MAST) for Chemistry." Journal of Chemistry Education, December, 1971, p. ; see also SMAC, Science and Math Education Information Report, 1971, p. 196.

[3]ibid, p.

the math competence as measured by MAST and the chemistry competence as measured by the ACS test.[4] (r = .38; where .01 level of significance = .217). MAST was shown to be a useful tool for predicting chemistry success, although achievement on both MAST and ACS tests were low.

The purposes, then of this research were: 1. to analyze the math skill competence of a diversified student population prior to chemistry enrollment and 2. to relate these competences to chemistry success.

PROCEDURE

In April, 1972, further investigation was initiated with two high schools, one in Nashville, Tennessee (designated Group A) and one in a suburban Boston area (designated Group B). Both schools offered 1st year chemistry in 11th grade, and wished to use MAST performance as diagnostic and rostering tools. Group A consisted of 105 10th graders predominantly middle class, mean age of 16; 2% black, 98% white; 1/3 girls and 2/3 boys; who attended a 4-year high school in Nashville, Tennessee with an overall student population of 1150. Group B consisted of 241 10th grade students, predominantly upper middle class, mean age of 16; 1% black, 99% white; 1/3 girls, 2/3 boys; attending a 3-year comprehensive high school in a suburban Boston area, with a total enrollment of 585.

Itwas agreed that MAST would be given in May, 1972 to all 10th graders who were eligible for the 11th grade chemistry. The MAST scores would be used to establish who could take chemistry in Fall, 1972, and what sections would be appropriate for what students.

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[4]R. T. Denny. "Questions About Inner City Chemistry," School Science and Mathematics, April, 1973.

TABLE 1

Individual Student MAST Score

Sample Student MAST Result

Smith, J.

	MAST Total	Level I	Level II	Level III
	52.75	14.75	28.50	10.50
max. score	60.00	14.00	32.00	14.00

	Skill #1	Skill #2	Skill #3	Skill #4	Skill #5
	41.25	7.00	3.75	18.25	20.75
max. score	46.00	8.00	6.00	23.00	23.00

	Skill #6	Skill #7	Skill #8	Skill #9	Skill #10
	15.75	5.00	5.00	5.50	4.75
max. score	18.00	6.00	6.00	9.00	7.00

As seen in Table 2, Group A from Nashville (n = 105) achieved a mean score of 26.4, standard deviation of 9.25 and test reliability of .870. Group B, (n = 241), near Boston, produced a mean score of 39.63, standard deviation of 10.19, and test reliability of .918. The scores indicated a range of achievement confirming the heterogeneity of pupils.

Teachers in both schools grouped their higher scoring students in advanced or accelerated chemistry, the average and below students in general chemistry with varying degrees of math emphasis, and planned math remediation sessions for the below-average group. Certain low achievers in MAST were advised not to take chemistry.[5]

In May, 1973, one year after taking MAST, the same students were rated on their chemistry success, in two different ways. Teachers in the Nashville high school felt that the goals of the different chemistry sections varied to the point that one objective standardized chemistry test was inappropriate for evaluating all the students. MAST scores were thus correlated with grades given by the chemistry teacher (Refer to Table 3). In evaluating

[5]A point of information: Certain students had achieved below one standard deviation from the mean of their group and were advised not to take chemistry but they insisted they wanted the course. These students encountered difficulty and dropped out during the year, or failed the course.

TABLE 2

Distribution of Scores on
Mathematics Skill Test, MAST

Spring, 1972

Group A
Nashville, Tenn. High School

```
 1 ( 1) *
 2 ( 0)
 3 ( 0)      N = 105
 4 ( 0)      Mean = 26.37
 5 ( 1) *    Standard
 6 ( 0)       Deviation = 9.25
 7 ( 0)      Reliability = .879
 8 ( 0)        (K-R#20)
 9 ( 0)
10 ( 0)
11 ( 1) *
12 ( 1) *
13 ( 1) *
14 ( 3) ***
15 ( 5) *****
16 ( 2) **
17 ( 3) ***
18 ( 3) ***
19 ( 6) ******
20 ( 4) ****
21 ( 5) *****
22 ( 2) **
23 ( 4) ****
24 ( 5) *****
25 ( 3) ***
26 ( 5) *****
27 ( 3) ***
28 ( 3) ***
29 ( 3) ***
30 ( 2) **
31 ( 4) ****
32 ( 3) ***
33 ( 4) ****
34 ( 6) ******
35 ( 4) ****
36 ( 4) ****
37 ( 1) *
38 ( 4) ****
39 ( 1) *
40 ( 2) **
41 ( 3) ***
42 ( 2) **
43 ( 0)
 . ( 0)
 . ( 0)
 . ( 0)
56 ( 0)
57 ( 1) *
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Group B
A suburban Boston, Mass. High School

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 3 (  1) *
 4 (  1)
 . (  0)      N = 241
 . (  0)      Mean = 39.63
 . (  0)      Standard
14 (  1) *     Deviation = 10.19
15 (  0)      Reliability = .918
16 (  0)        (K-R#20)
17 (  0)
18 (  1) *
19 (  1) *
20 (  0)
21 (  1) *
22 (  0)
23 (  4) ****
24 (  2) **
25 (  5) *****
26 (  3) ***
27 (  6) ******
28 (  4) ****
29 (  6) ******
30 (  7) *******
31 ( 13) *************
32 (  4) ****
33 ( 12) ************
34 ( 16) ****************
35 (  5) *****
36 (  9) *********
37 (  5) *****
38 (  4) ****
39 ( 10) **********
40 ( 10) **********
41 (  9) *********
42 (  7) *******
43 (  4) ****
44 (  7) *******
45 (  6) ******
46 (  3) ***
47 (  6) ******
48 (  7) *******
49 ( 14) **************
50 (  5) *****
51 (  7) *******
52 (  5) *****
53 (  5) *****
54 (  5) *****
55 ( 13) *************
56 (  1) *
57 (  4) ****
58 (  1) *
59 (  1) *
```

TABLE 3

Correlation
of
The Mathematics Skill Test (MAST)
and
High School Chemistry Grades

N = 46

Grades	MAST total score
1st Semester	.309*
Final Grade	.356*

* df 45, significance for .05 level = .288

Note: Of the 105 who took MAST in Spring, 1972 46 took chemistry in September, 1973.

Group B, the teachers agreed that the 1969 ACS-NSTA High School Chemistry Test was an adequate evaluation mechanism for their chemistry courses. The ACS and MAST scores generated the correlations shown in Table 4.

RESULTS AND CONCLUSIONS

Group A students from Nashville, Tennessee with MAST scores ranging from 1 to 42, and a standard deviation of 9.25 about a mean of 26.4, demonstrated a lower average performance and less of a heterogeneity of student performance than Group B. Of the 105 students who took MAST in Spring, 1972, 50 entered a chemistry course. 46 finished the course. MAST scores were used by the teachers of Group A for rostering: the students scoring above 30 (maximum score = 60) could go into advanced chemistry using CHEM Study. Students scoring between 19 and 30 were divided into two sections of general chemistry using Chemistry: An Investigative Approach (Cotton and Lynch, 1970). The students from the advanced section took the College Board Achievement Test in Chemistry and scored well, giving a mean above 650. The students scoring 17 or below were advised not to take chemistry. Of these, 8 took chemistry; four failed the course and four dropped the course before May, 1973. Math remediation was voluntary, with specific materials made available upon student request, plus a 10-minute daily review of math skills for the first 3 weeks of the term.

Group B, consisting of 241 students from an area outside Boston, scored between 3 and 59, producing a standard deviation of 10.19 around the mean of 39.63, indicating a greater diversification of students than Group A. Of these 241 students, 188 finished a chemistry course in June, 1973. Three types of chemistry programs were offered to these students: Accelerated chemistry (Foundations of Chemistry Toonand Ellis, 1968), quantitative chemistry (CHEM STudy), qualitative

TABLE 4

Group B Correlation
of
The Mathematics Skill Test (MAST)
with
1969 ACS-NSTA High School Chemistry Test

N = 188

MAST SCORES	1969 ACS-NSTA High School Chemistry Test Scores	
	Raw	Percentile
Total	.731*	.728*
Level 1[a]	.586*	.577*
2[b]	.694*	.691*
3[c]	.658*	.658*
Skill 1 Computation	.725*	.718*
Skill 2 Parentheses	.562*	.577*
Skill 3 Signed numbers	.550*	.550*
Skill 4 Fractions	.700*	.700*
Skill 5 Decimals	.697*	.690*
Skill 6 Percent	.695*	.694*
Skill 7 Exponents	.587*	.584*
Skill 8 Equations	.524*	.521*
Skill 9 Ratio and Prop.	.637*	.641*
Skill 10 Graphs	.392*	.395*

* df, significance for .01 level = .244

[a]Level 1 items use one math skill nonverbally.

[b]Level 2 items use 2 or more math skills nonverbally.

[c]Level 3 items are simple verbal problems.

chemistry (Modern Chemistry, Dull and Metcalfe, 1970.) Accelerated chemistry and quantitative chemistry rostering included students above the mean of 39.6, on MAST, where maximum score possible was 60. Students scoring between 30 and 39 were free to elect either of the other two courses, quantitative or qualitative. Using the MAST scores of the 36 students scoring below 30 on MAST, 12 were advised not to take chemistry, but 9 did. Three of these dropped out during the academic year; 3 failed the first semester and received D's as a final grade; 2 failed the course. MAST Test results were also used to identify students with potential problems in certain math skills. MAST performance was discussed with these students and tutoring sessions were set up, with attendance voluntary. Both teachers and students felt these remedial meetings were helpful and that MAST proved of value as a diagnostic tool.

In examining the values obtained from comparing MAST and grades in Group A and MAST - ACS correlations for Group B, two distinct areas are significant:

1. Despite the gap of one year between math and science evaluations and the math skill remediation given to some students MAST is an effective predictor of chemistry achievement; and

2. MAST can provide an objective math skill performance profile which the teacher and the student can use to individualize the chemistry program for the student.

As seen in Table 4, the correlations obtained in comparing ACS raw scores or ACS percentiles with MAST achievement are all consistently high, ranging between .73 and .52, with the exception of one MAST subscore, graphing. The .39 correlation obtained between MAST graphing skill and ACS is significant but also informative. It implies that graphing techniques were taught more frequently during the year than the other skills, in conjunction with the chemistry course.

In comparing the correlations between Groups A and B, please note that these are not interval values (eg..17 is not half as good as .34). Certain points of inspection can prove useful, however:

1. One can expect a higher value of correlation in comparing scores of two objective test measures;

2. if in your judgment as a teacher the ACS-NSTA High School Chemistry Test measures the goals of your chemistry course, then MAST, is an excellent predictor of student success and indicates those who need math remediation;

3. one would expect lower values of correlation in comparing scores of MAST objective tests with subjective grades, since grades include a teacher evaluation of all the student behaviors during the chemistry course; and

4. where one objective test does not serve to evaluate the goals of all the students enrolled in chemistry for the year, MAST is a significant predictor of those who will succeed and of those who will need math remediation.

In conclusion, a few comments from the teachers and students can be of value:

The students enjoyed taking the MAST test: "It wasn't tricky, and I knew what to do."

In discussing test results with the student individually the student was relieved to have some objective evidence visible to both student and teacher as a baseline for remediation: "I knew I couldn't do percents--see, this subscore shows it."

The teachers profited by using MAST results: "I could anticipate which students might have difficulty before the student's frustration built up; and algebra grades did not show this."